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[12] Wiley, B. I. 1992. The life of Billy Yank. Louisiana State University Press, Baton Rouge, LA p. 136 [454 pp.]

[13] Spencer, A. 1866. A Narrative of Andersonville, Drawn from the Evidence Elicited on the Trial of Henry Wirz, the Jailer. Harper & Brothers, NY. p. 270 [272 pp.]

[14] Cordell, E. F. 1903. The Medical Annals of Maryland, 1799-1899. Williams and Wilkins Co., Baltimore, MD p. 636 [889 pp.]

[15] Wiley, B. I. 1994, op. cit., p. 249

[16] Cunningham, H. H. 1958. Doctors in Gray: The Confederate Medical Service. Louisiana State University Press, Baton Rouge, LA p.180 [338 pp.]

[17] Woods, J. T. 1874. Services of the Ninety-sixth Ohio Volunteers. Blade Printing and Paper Co., Toledo, OH. p. 95 [247pp.]

[18] Glatthaar, J. T. 2002. The common soldier of the Civil War p.135 *in* [J. Y. Simon and M. E. Stevens eds.] New Perspectives on the Civil War: Myths and Realities of the National Conflict Rowman & Littlefield [200pp.]

[19] Wiley, B. I. 1992. op cit., p. 134

[20] Gob, G. N. 2002. The Deadly Truth: A History of Disease in America. Harvard University Press, Cambridge, MA. p. 147 [349pp.]

[21] Wiley, B. I. 1992. op cit., p. 134

[22] Churchman, J. W. 1906. The use of quinine during the Civil War. Johns Hopkins Hospital Bulletin. 17:175-181.

[23] Boatner, 1959, p. 171; Deen 1983, p. 15; Garrison, W. 1994. Civil War curiosities: strange stories, oddities, events, and coincidence. Rutledge Hill Press, Nashville, TN p. 210 [281 pp.]

[24] Johnson, N. F. and C. A. Triplehorn. 2005. Borror and DeLong's Introduction to the Study of Insects. Thompson Brooks/Cole Pub., Belmont, CA p. 362 [864 pp.]

[25] Wiley, B. I. 1994. op. cit. [p. 250]; Nash, E. A., 1911. A History of the Forty-fourth Regiment New York Volunteer Infantry in the Civil War, 1861-1865. R. R. Donnelley & Sons Company, Chicago, IL p.273 [484 pp.]; McGee, B. F. 1882. History of the 72d Indiana Volunteer Infantry of the Mounted Lightning Brigade. S. Vater & Co., LaFayette, IN, p. 73 [719pp.]; Genoways, T. & H. H. Genoways. 2001. A perfect picture of hell: eyewitness accounts of Civil War prisoners from the 12th Iowa. University of Iowa Press, Iowa City. IA. p. 50 [337 pp.]

[26] Tomlinson, H. W. (ed.). 1962. Dear friends, the Civil War letters and diary of Charles Edwin Cort. [publisher not given].p. 77 [194 pp.]

[27] Ransom, J. L. 1963. John Ransom's dairy. Paul S. Eriksson, New York, NY. p. 80 [283 pp.]

[28] Billings,op. cit., p. 80

[29] ibid

[30] McElroy, J. 1879. Andersonville: A Story of Rebel Military Prisons. D. R. Locke, Toledo, Ohio. p. 166 [654 pp]

[31] Billings, op. cit., p 88

[32]Wiley, B. I. 1994. op. cit., p. 250

[33] Watkins, S. R. 1999. Co. Aytch or , A side show of the big show. Inge, M. T. (ed.) Plume, Penguin Putnam, Inc., New York, NY p. 39 [274 pp.]

[34] Humphreys, M. 2006. A Stranger to Our Camps: Typhus in American History. Bulletin of the History of Medicine 80(2): 269-290

Military medical entomology during the Mexican-American and First World Wars: A coming of age

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An inchoate appreciation for the profound impacts poor field sanitation exacted on troop strength and morale during the Civil War led to the establishment of the US Sanitary Commission in 1861. Even so, a full realization of the critical role sanitation and insect control play in the prevention of communicable diseases had to await the birth of medical entomology brought about by the brilliant discoveries of pioneers in tropical medicine decades

later. Indeed, the Spanish-American War reemphasized that we had not learned our lessons in exposing immunologically naïve troops to exotic diseases and those caused by poor sanitation, and enormous numbers of communicable disease casualties were the predictable results. In time, improved weaponry and a realistic appreciation for the force-multiplicative capabilities of proper field sanitation and hygiene tilted casualty totals in favor of disease forever thereafter.

The Beginnings

This is not to say that a connection of insects with disease hadn't been previously entertained. Doctor John Crawford of Baltimore published some ideas on the possible association of mosquitoes with malaria in 1807 (Bryan et al. 2004). Doctor Josiah Nott had expressed similar ideas in 1848 in South Carolina (Chernin 1983). It was in the late 19th century, though, that the connection between insects and certain diseases began to take shape. In 1882 an English expatriate physician, Albert Freeman Africanus King, read a paper "Insects and Disease - Mosquitoes and Malaria" before the Washington Philosophical Society. In the paper, Dr. King listed 19 reasons why he believed malaria was transmitted by mosquitoes. The paper was subsequently published in the Popular Science Monthly in September 1883 but drew little interest because of King's reputation as a scientific gadfly. This was not helped by his insistence that malaria could be controlled in Washington DC by erecting mosquito netting to the height of the Washington Monument around the entire city (Daniels 1950).

Prior to our understanding of the role of insects in disease transmission with the findings of Smith, Ross and Manson, a number of interesting entomological observations were contributed by military medical officers as a result of epidemiological investigations. Differential attack rates for yellow fever among blacks (10.7% fatality rate) and whites (31.6% fatality rate) in the military led to increased study of the disease. Impetus was also gained from deaths due to yellow fever after the Civil War. For instance, 27 fatalities due to yellow fever were recorded from Fort Jefferson in Florida in 1867, while another 13 fatalities occurred at the same base in 1873. A total of 12 soldiers died at Fort Barrancas in Pensacola in 1869 (Sternberg 1899). A survivor of that epidemic, George M. Sternberg, was eventually assigned to the Havana Yellow Fever Commission and became extremely influential in the growth and maturation of military preventive medicine in later years[5].

Spanish-American War

The Spanish-American War, involving only 118 days of hostilities, nonetheless graphically demonstrated the consequences of inadequate medical resources, particularly in preventive medicine, on troop health in garrison settings. The rapid mobilization of forces strained medical assets and resulted in significant morbidity due to typhoid in garrison settings. The force structure figures below reflect a dramatic increase in troop concentrations occurring in an extremely brief period.

Force Structure
1.April 1898 - 28,183 officers and enlisted men.
2.May 1898 - 163,592
3.July 1898 - 265,629
4.August 1898 - 272,618, peak army strength

Vector-borne disease casualties were of little significance during the conflict, but commanders were clearly concerned about exotic diseases affecting troops if deployed for extended periods. In July, immediately after the Battle of Santiago, Theodore Roosevelt wrote: "If we are kept here it will in all human possibility mean an appalling disaster, for the surgeons here estimate that over half the army, if kept here during the sickly season, will die."

The most serious confrontation with communicable disease occurred at Camp Wickoff, a temporary Federal demobilization and quarantine camp for troops returning from Cuba. The camp, named for Col. Charles Wikoff (22nd Infantry, killed at El Caney), was established in August-September of 1898 in the vicinity of Fort Pond Bay, Montauk Point. The site was selected for its proximity to rail and deep-water anchorage, and because it was believed prevailing offshore winds would hinder spread of tropical diseases to the civilian population. In excess of 20,000 returning soldiers were brought in by ship during the August to October timeframe, and 275 perished from typhoid as a result of grossly inadequate sanitation facilities. In fact, regiments in all of the stateside camps suffered 20,738 cases of typhoid fever, resulting in 1,590 fatalities. Typhoid fever accounted for 87% of all deaths attributable to disease (2957 – compared to 332 combat fatalities) during and after the conflict (Gibson 1958).

Investigations into the causes of this level of communicable disease were initiated on the orders of then Surgeon General George Sternberg. The so-called Reed-Vaughan-Shakespeare Typhoid Board eventually concluded that flies were a major culprit in the spread of the disease (Reed et al. 1940). At the same time, SG Sternberg established other boards to study infectious disease in the Philippines (plague) and Cuba. The value of these boards in expanding our knowledge of communicable disease spread was duly recognized and eventually resulted in Sternberg establishing the Medical Reserve Corps – out of which specialists in disease transmission and control could be drawn (Bayne-Jones 1968).

Integrated Vector Control – Havana

I have purposely avoided addressing the immensely important discovery of *Aedes aegypti* as the vector of yellow fever because the subject requires in-depth treatment well beyond the scope of this paper to attribute it due respect. Nonetheless, William Crawford Gorgas, when appointed Chief Sanitary Officer of Havana, Cuba, accepted the evidence provided by the Reed Commission that the mosquito, *Stegomyia fasciata* (*Aedes aegypti*), was the sole transmitter of yellow fever and immediately began preparations to rid the city of yellow fever. He was aware also of the recently proven transmission of malaria in man by anopheline mosquitoes and used this information to strengthen his case for comprehensive vector control within the city limits.

The military aspect of Gorgas' control measures cannot be over-emphasized. Gorgas enjoyed the full support of General Leonard Wood, Governor General of Cuba, and used this relationship to its full advantage in devising and implementing control measures. Upon Wood's declaration of martial law, Dr. Gorgas divided Havana into 20 districts and assigned teams of sanitation officers to each sector. The

inspectors were placed in charge of so-called "Stegomyia Brigades." These units provided mosquito control services to those areas reporting yellow fever cases. Initially, Gorgas issued orders to the general public of Havana to oil or screen their barrels of drinking water. All cases of yellow fever were required to be immediately reported to American authorities. Upon receiving the report, sanitation officers from the applicable Stegomyia Brigade were sent to the victim's house to begin fumigation, sealing the house and burning pyrethrum to kill any mosquitoes inside. Ultimately, he drove yellow fever out of the city. During his first year of control measures, approximately 300 deaths in Havana were due to yellow fever. After 26 September 1901, there were no further cases. This was the first triumph over an insect-borne disease of man based upon bionomics of the vector and knowledge of the cycle of the parasite – although conceived by a military physician, not an entomologist. This also provided the basis for the integrated vector control techniques we utilize to this day.

Gorgas further utilized the military paradigm in his 10-year battle against vector-borne disease in the Canal Zone. The Stegomyia Brigade concept proved so successful that Ronald Ross discussed the initiation of organized mosquito control brigades in a technical manual he developed during his later years lecturing on applied vector control (Bayne-Jones 1968). Despite the lack of full understanding and opposition of the project engineers, Gorgas succeeded in freeing the Canal Zone of yellow fever in two years; the final indigenous case occurred there in May 1906. Malaria was also greatly reduced by instituting a variety of large-scale integrated anti-mosquito measures, such as ditching, draining, larviciding, fumigating, and screening. Colonel Gorgas claimed that during the construction of the Panama Canal the Sanitary Department, which he headed, had saved 71,370 human lives and the prevention of a vast amount of disability from sickness. He did not fully disclose his methodology for arriving at this number, but it is clear that his control strategies saved an enormous number of lives, time and money (Gorgas 1903).

World War One

Here again, rapid mobilization of troops overwhelmed resources to properly house them and resulted in enormous numbers of disease casualties. Of the 112, 422 deaths recorded, 56,206 were from disease. A total of 33,062 of these occurred stateside, while 23,144 occurred in the expeditionary forces (Duncan 1914). This was attributed to poor sanitation and overcrowding. The lessons of the Spanish-American War had not been entirely ignored, as there was a rudimentary program available for pest control training. Unfortunately, malaria (truthfully, as it turned out) was not considered a serious threat in France and areas of Europe in 1914. Thus, little attention was given to the protection of troops from mosquitoes, lice and other pests overseas. Ironically, extensive drainage programs were carried out at training camps stateside in the southern states, with over 3 million dollars expended. This was an enormous sum of money at the time and underscores the emerging realization of the toll mosquito-borne diseases could exact on forces preparing for war. Unfortunately, entomologists did not always supervise the drainage schemes. Furthermore, they were not considered overly successful

since 9,617 cases of malaria were reported among troops in training camps during this period, resulting in a total of 115,000 man-days lost from training. In point of fact, there were several entomologists and biologists on duty in the armed forces during WWI. Herms and Van Dyne were commissioned in the Sanitary Corps and worked on entomological problems (Dews et al. 1960).

Interestingly, as the war increased demand for agricultural products, agricultural pest control assumed a greater importance. Large troop concentrations, food shortages, poor sanitation and epidemics became not just public health, but military problems also. Indeed, chemical warfare and pest control industries created tools used by each other. There is little doubt that World War I stimulated the creation, growth and linkage of military/civilian chemical capabilities, transforming the United States into a world chemical power. It can be said that chemical warfare capability and vector control co-evolved to meet the needs of the war machine. Gas and explosive (explosives use picric acid, a process that produces paradicholorobenzene) production stimulated an enormous amount of research into organic chemistry that spun off into products to combat cotton pests. This was further pushed as prices rose precipitously on cotton due to war demand.

The military mindset continued to exert its influence over pest control during this period, reflecting the dominant role played by the military in the evolution of means to control vector populations. During this war period, our culture even began using military metaphors for pest control. The August 1915 edition of *Living Age Magazine* contained an article in which it was stated "We shall conquer if we realize in time the seriousness of this war against the arthropod; as no doubt we shall get the better of the Teuton and Magyar if we brush aside half measures." Also at this time, Dr. Stephen Forbes, an entomology professor at the University of Illinois and president of the Entomological Society of America, was quoted in a 1917 Chicago Herald article entitled *Fifty Billion German Allies Already in the American Field* as saying "In wartime the US needs carefully planned campaigns run by organized communities, participated in by everyone as to be available, directed by experts and financed as far as is necessary by the state." The military paradigm, the result of 20 years of research and applied vector control, had finally taken root in the American psyche.

Troops engaged in trench warfare in Europe were often infested with lice. There was no satisfactory way of controlling the lice. Methods recommended included the Serbian Barrel, dry heat, fumigation and hand collecting. The treatments were difficult to apply in the field and had no residual effect. Little or no emphasis was placed on the control of flies, roaches, bed bugs, chiggers, ticks, and insects infesting food supplies. As stated by L. O. Howard, "They did not stop to think of the very great importance of insects in the carriage of certain diseases, the ease and frequency of such transfer becoming intensified wherever great bodies of men are brought together, as in great construction projects, and especially in great armies. They did not realize, entirely aside from the special diseases of this character met with by the troops in Africa, Mesopotamia and in the

region of Salonika, that even upon the western front, in a good temperate climate, warfare under trench conditions was rendered much more difficult by reason of the prevalence of trench fever which investigations during the latter part of the war showed to be carried by the body-louse." (Howard 1919).

The tactical stalemate resulting in trench warfare caught both sides woefully unprepared. The allied expeditionary force actually preferred attack, and thus had no provision for long-term supply of its troops. This had disastrous consequences. Doctrine evolved to plan baths for troops every 10 days. Fires were forbidden. As a result, troops huddled for warmth, facilitating the transfer of body lice. Robert Graves, in his autobiography "Good-bye to All That," put it humorously: "We once discussed which were the cleanest troops in the trenches, taken by nationalities. We agreed on a descending-order like this: English and German Protestants; Northern Irish, Welsh and Canadians; Irish and German Catholics; Scots; Mohammedan Indians; Algerians; Portugese; Belgians; French. We put the Belgians and French there for spite; they could not have been dirtier than the Algerians and the Portugese." (Graves 1960). J.R.R. Tolkein, an infantryman who spent a great part of the war in the trenches, remarked that the scene depicted in his novel The Two Towers, where the protagonist Frodo looks into the swamp water and sees the faces of corpses, is taken directly from his experiences with dead comrades in the trenches.

A good deal of literature is available on the effects of louse-borne typhus on strategy and tactics on both sides during WWI, and I shall not treat it in any depth here. It appears that Allied/German soldiers in the trenches of the Western Front were as universally lousy as their colleagues in the East but did not suffer louse-borne typhus. Cogent explanations are few, but the Central Powers, realizing that a typhus fever epidemic introduced with troops transferred from the East could easily lose them the war, took the utmost precautions to avoid this. Troops were deloused whenever they fell back from the front lines. Evidently the louse-borne typhus epidemic that cost the Prussians the War of the Austrian Succession during the siege of Prague (1742) taught them a lasting lesson.

While typhus did not make itself known to any great degree in he Western trenches, a separate louse-borne disease, trench fever, caused considerable morbidity. Discovered in 1915, trench fever had disappeared by 1918, having infected over 800,000 allied soldiers, resulting in an enormous number of man-days lost.

Louse control measures available to the infested troops were crude at best. Treatments were extremely varied and of marginal effect. Naphthalene, creosote, iodoform (NCI) powder or paste, proprietary mercury preparations (Indian troops preferred this method) and sulfur bags (2" square, preferred by South African troops) were but a few of the controls used. Infested clothes were treated with either dry or wet heat.

It is clear that sanitation standards attendant to trench warfare were inadequate. Nonetheless, efforts were made to address the shortfalls at both the command and small unit levels. Hans Zinsser, a professor of bacteriology and immunology successively at Stanford, Columbia, and Harvard Universities, rose to the directorship of communicable disease control and prevention activities

in the American Expeditionary Forces in France during World War I. While serving as a Sanitary Inspector of the Second Army at that time, Zinsser published a general order on "Sanitation of a Field Army," formally establishing acceptable public health practices designed to lower communicable disease incidence in the expeditionary forces. After the war, he wrote a delightful book, "Rats, Lice and History," detailing vector-borne disease impacts on military operations and societies in general, that remains the foremost work on the subject.

Zinsser pursued his career in preventive medicine after the war and served as a consultant to the Surgeon General on the subject for several years afterward. Under his wise and experienced tutelage, medical doctrine in the United States military began to reflect the integrative nature of preventive medicine, compelling practitioners to embrace a number of varied disciplines to ensure more efficient and long-term public health outcomes. Dr. Zinsser wrote: "Just as the laboratory is of partial efficiency only in hospitals if the bacteriologist is unfamiliar with the cases in the wards, so in armies the laboratory service cannot be entirely efficient unless the laboratory officer is trained in and in touch with the epidemiological data. For this reason, the Sanitary Inspector of the Army, who should be capable of acting as an adviser to medical officers and sanitary inspectors of the several troop units, should be a man not only trained in practical sanitation but one who at the same time is familiar with the facts of epidemiology, the methods of making epidemiological surveys, and can handle a laboratory for the control of communicable diseases as an important tool of his profession." (Zinsser 1919).

Between Hostilities

Realizing the critical nature of timely environmental health interventions upon full force mobilization, the National Defense Act of June 4, 1920 established the Sanitary Corps Reserve as an on-call cadre of sanitation expertise, stating that "...there be organized under the Medical Department for the period of the existing emergency a sanitary corps consisting of commissioned officers." The sanitary corps would primarily be staffed through assignment or appointment of Medical Reserve Corps officers. Dr. William Herms was the first entomologist commissioned in the Sanitary Corps reserve. Dr. Herms noted that 6-8 entomologists and parasitologists in the Sanitary Corps were assigned to "malaria drainage detachments," comprising about 300 officers and men. The work of the entomologists in these detachments was integrated with that of the sanitary engineers.

Herms further stated "This background of military experience, particularly in the Medical Department of the Army, together with some early experience as an infantryman, no doubt, caused me to give emphasis to medico- military problems in my course in "Medical Entomology" particularly from 1919 on. Many of my former students now on duty as sanitary officers in World War II have reminded me of this and have expressed approval." (Herms 1945). In recognition of its manifest contributions to troop health and morale, entomology was listed as one of the professional interest groups in the Sanitary Corps in Army Medical Bulletin No. 21 (1927).

Only 14 entomologists eventually took advantage of the opportunity

afforded. These were called to duty early in WWII and formed the nucleus from which developed the greatly expanded services of entomologists in WWII. Civilians deemed expert in sanitation, sanitary engineering, bacteriology, or other sciences related to sanitation/preventive medicine, or possessing other knowledge of special advantage to the Medical Department, such as medical entomology, were also to be identified as ready reserve assets.

A direct result of the experiences gained in tropical medicine and hygiene during the First World War was the founding and expansion of schools of public health in the United States. The students trained at these institutions eventually formed the basis for medical entomology practice during WWII.

The first school of training in public health and preventive medicine in this country was the Army Medical School, reflecting a profound appreciation for the critical nature of force readiness and the force-multiplication attributes of environmental health.

Shortly thereafter, a school of sanitarians at the Massachusetts Institute of Technology was initiated as a result of Sedgwick's epidemiological investigations in the 1890's. This merged with Harvard University in 1913, forming the Harvard-MIT School of Public Health, and became the first civilian school of public health in the United States. It was reorganized in 1918 and named the Harvard University-Massachusetts Institute of Technology School of Public Health. In 1922, the school was separated from MIT and thereafter has been designated the Harvard School of Public Health.

The Johns Hopkins University School of Hygiene and Public Health was formed and began operations in 1918. In succeeding years, these were followed by schools of preventive medicine and public health at six more universities.

Conclusion

An appreciation of the profound impacts vector-borne diseases exert on immunologically naïve populations, gathered through experience and research accomplished, in large part, by specialists from military preventive medicine units, laid the foundation for organized military entomology programs that have demonstrably saved thousands of lives in exotic locales during wartime (Bayne-Jones, op.cit. p. 157). The exigencies of warfare, determined as they are by troop health and morale, inexorably drove military doctrine toward inculcation of unit specialists in sanitation and, eventually, medical entomology. The process of recognizing the impact of communicable disease on force readiness was, in retrospect, slowed by a paucity of information tying disease to specific vectors. However, military medical personnel were - and remain - at the cutting edge of tropical medicine.

References

Bayne-Jones, S. 1968. *The Evolution of Preventive Medicine in The United States Army*, 1607-1939, Office Of The Surgeon General Department of the Army, Washington, D.C..

Bryan, CS, Moss, SW. Khan, R.J. 2004. Yellow Fever in the Americas. *Infectious Disease Clinics of North America,* 2004. 18(2): 275 – 292.

Chernin, E. 1983. Josiah Clark Nott, Insects, and Yellow Fever. *Bull N Y Acad Med.* 59(9): 790–802.

Daniels, WB. 1950 Albert Freeman Africanus King (1841-1914); His Theory as to the Transmission of

Malaria by Mosquitoes. *Med Ann Dist Columbia.* 19(9): 499-505.

Dews, SC, Blakeslee, TE, Knight, K. L, Hurlbut, HS. Circa 1960. *Report*. 29 pp.

Duncan, LC. 1914. The Comparative Mortality Of Disease And Battle Casualties In The Historic Wars Of The World. *J Mil Serv Inst US*. 54:140–177.

Gibson, JM. 1958. Soldier in White. The Life of General George Miller Sternberg. Durham: Duke University Press.

Gorgas, WC. 1903: A Short Account of the Results of Mosquito Work in Havana, Cuba. *J. Assoc. Mil. Surgeons* 12: 133-139.

Graves, R. 1960. Goodbye To All That. Harmondsworth: Penguin.

Herms, WB. 1945. Medical Entomology Meets the Impacts of War. *J Econ Entomol*. 38(1): 8-12.

Howard, LO. 1919. Entomology and the War. *Scientific Monthly*. 109-117.

Reed, W, Vaughan, VC, Shakespeare, EO. 1940 : Preliminary Report on Typhoid in Military Camps of the United States. To: The Surgeon General of the Army. Washington, D.C., 25 Jan. 1899. *Army M. Bull*., 53, pp. 73-103.

Ross R. 1902. Researches on malaria. Nobel Lecture, December, 12, 1902. (From *Nobel Lectures, Physiology or Medicine 1901-1921*, Elsevier Publishing Company, Amsterdam, 1967.

Sternberg, GM. 1899. Sanitary Lessons of the War. *J.A.M.A.* 32 (23): 1287-1294.

Zinsser, H. 1919. The Sanitation of a Field Army. *Mil. Surgeon*, 44: 445-464; 571-581.